Medical faculty's use of print and electronic journals: changes over time and in comparison with scientists

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Objectives: The objectives are to determine how medical faculty members use scholarly journals, whether print or electronic journals are read more, whether there is a pattern among types of users, and what similarities and differences there are between the use of journals by medical faculty and faculty in other disciplines.

Methods: Medical faculty of the University of Tennessee Health Science Center (UTHSC) multi-campus system were surveyed, and their responses estimated using critical incident technique to characterize the different aspects of their use of print and electronic journals.

Results: Medical faculty read a great deal, especially compared to scientists. The most frequently reported principal purpose of reading is to support their primary research (30% of reading). The majority of reading comes from recently published articles, mostly from personal subscriptions. Medical faculty continue to rely on print journals (approximately 70% of readings) versus electronic journals. Age of faculty does not appear to influence the choice of print or electronic format. Medical faculty read more articles than others on average and need information digested and verified in a way to save them time. Convenience and currency are highly valued attributes.

Conclusions: It can be asserted that librarians and publishers must find ways to provide the attributes of convenience and currency and match the portability of personal subscriptions in an electronic journal format for medical faculty.

INTRODUCTION

The scholarly scientific, technical, and medical journal systems are undergoing tremendous change. With steady increases in the price of print subscriptions, the number of subscriptions has declined correspondingly. Studies show that there are now many alternatives to print journals, including electronic peer-reviewed versions of traditional journals from the same publishers, aggregated databases of separate articles, electronic print servers, institutional open archives, and author's personal Web pages [1–3]. E-print servers, such as arXiv.org, provide access to separate articles that may be preprints of articles that will be submitted to peer-reviewed journals by the author, postprints (copies of articles that are also published in journals), or papers that will never be submitted to traditional journals. The Open Archives Initiative* promotes common interoperability to allow institutions or individuals to develop e-print repositories. Electronic versions of traditional journals change the publication system the least, as they may merely provide more convenient access to subscription-based journals. E-print servers or open archives have the potential to induce more profound changes in the publication system as they already change the publishing system from a journal title model to a separate articles model and may be accomplished independent of publishers. Tenopir and King [4], in previous studies, have discovered that medical faculty may be more resistant to change than faculty in other disciplines, because, traditionally, they use journals for much of their professional development and to stay current with progress and trends in their field.

Many studies over the last decade show that the adoption rate for electronic journals, the viability of alternatives to the traditional print or electronic peer-reviewed journal system, and the pace of change vary considerably by field [5, 6]. Meadows reports that, in the print world, medical professionals have relied heavily on scholarly journals, placing importance on specific journal titles in their subdisciplines and reading more than people in most other disciplines [7]. It is therefore interesting and timely to see how much of an impact electronic alternatives have had on medical faculty and to compare their information seeking, their reading patterns, and their adoption rates to those of scientists.

The study reported here surveyed medical faculty members in the University of Tennessee system to discover how they use journals and alternatives to journals. Because the authors have also surveyed other disciplines using the same questions, the medical respondents can be compared to scientists. This study addresses four main research questions:

1. How do medical faculty use scholarly journals?
2. Are print articles or electronic articles read more?
3. Is there a pattern among the types of users (educational background, field of medicine) in their use of electronic resources versus print resources?
4. What are the similarities and differences between the use of journals for medical faculty and faculty in other disciplines?

LITERATURE REVIEW

Recent studies in other institutions suggested that health sciences faculty still relied on scholarly journals. Curtis, Weller, and Hurd [8] found that health sciences faculty frequently used their personal subscriptions as a source of journal articles. For example, 77.9% of medical faculty, 68.2% of nursing faculty, and 86.7% of pharmacy faculty used personal subscriptions for copies of articles they needed. This was much higher than other fields. In a study by Hurd et al. [9], faculty at the University of Illinois at Chicago in the fields of biological sciences, chemistry, geological sciences, mathematics, statistics and computer science, physics, and engineering were surveyed. They found that 78% of the scientists and 54% of the engineers read journals in the library; a larger percentage of scientists and engineers in Hurd's study photocopied from the library for later reading at other locations. A comparison of Hurd et al. with the Curtis, Weller, and Hurd [10] study demonstrated that medical faculty made use of their personal journal subscriptions as much as other scientific fields make use of library subscriptions. Tenopir and King found that, on the whole, personal print or electronic subscriptions by scientists have declined from 5.8 subscriptions per scientist in 1977 to 2.2 subscriptions in 2000 to 2001 [11]. This decline can be mostly attributed to the rising costs of print journals. This personal subscription decline might not be true of medical faculty.

Medical faculty continue to use journal articles as the preferred source of information. This is consistent with patterns reported in the past. Stinson and Mueller [12] surveyed 402 health care professionals' information habits and needs. The health care professionals surveyed included physicians (who comprised 77% of the sample), dentists, optometrists, nurse practitioners, and physical and occupational therapists. Medical journals were the most common medical information source, followed by consultations with professional colleagues, association meetings, continuing education courses, and pharmaceutical representatives, in that order. Ninety-nine percent of health professionals reported using medical journals; they spent an average of approximately 5 hours per month using them.

Stinson and Mueller [13] found that personal subscriptions were the most common source for articles, followed by unsolicited medical journals. Comparatively few reported regularly using a hospital or medical school library to obtain medical articles. Lundeen, Tenopir, and Wermager [14] also found that the majority of respondents to their survey of rural health practitioners in Hawaii use journal articles obtained from a personal collection or a colleague's collection to meet their information needs.

* The Open Archives Initiative Website may be viewed at http://www.openarchives.org.

When journals are convenient to access, use may be even higher among medical faculty and practitioners. Some studies have identified certain difficulties that physicians have with using journal literature. Huth [15] identifies a number of reasons medical practitioners do not make even more frequent use of the medical literature, including papers relevant to specific clinical issues that are widely scattered across journals with different subject boundaries; the time involved in searching and retrieving articles; and the time involved in sifting through the retrieved literature, much of which is not relevant to clinical problems.

Williamson et al. [16] conducted a survey of 625 primary care physicians and 100 physician opinion leaders, comprised mostly of academic faculty. Two-thirds of the office-based practitioners and half of the opinion leaders said they found the volume of medical literature to be unmanageable. The major problems identified were a lack of time to search for information and a large amount of irrelevant material that must be screened to locate the desired information. Eighty-seven percent of office-based practitioners said that most physicians have at least moderate difficulty with inadequacies of terms used in MEDLINE (*Index Medicus*) or other journal databases.

Despite the evidence that health sciences faculty relied on personal subscriptions, De Groote and Dorsch, at the Library of the Health Sciences-Peoria, a regional site library of the University of Illinois at Chicago, found that introducing online journals had a negative impact on the use of print journals [17]. A major decrease in the use of print journals occurred following the introduction of 104 online core medical journals. This decrease in print journal use suggested that users preferred online journal access to print journal access. Conversely, Sathe, Grady, and Giuse [18] found that clinical/research faculty use print journals more than other types of users (i.e., fellows, nurses, residents, nursing students). In this same study, users reported that print journals were used for reading articles and scanning contents and that print formats contain higher-quality text and figures. Electronic journals were used for performing reference checks, and many articles were printed out. They were judged to be more easily accessible and searchable than print journals.

METHODS

Survey sample and respondents

The population for this survey is the medical faculty at the University of Tennessee (UT). Based in several sites in the multi-campus university system, the UT system includes colleges of allied health sciences, dentistry, graduate health sciences, medicine, nursing, and pharmacy; the school of biomedical engineering; family medicine centers; and the University of Tennessee Medical Center hospital. Currently, there are more than 1,000 faculty members total.

As part of a larger UT survey, the survey instrument was sent to a random sample of 263 faculty members in both Memphis and Knoxville locations in the academic year 2000/01. Because the initial response rate was low, the authors sent email reminders and an additional mailing, which brought the rate up to a total of 79 respondents who returned the survey (30% response rate). In other surveys, we have used Web-based questionnaires and have found the response rate to be no better. The respondents represented a variety of medical professionals with various educational backgrounds, including 44% with a doctorate only, 44% with a medical degree only, 5% with neither degree, and 1% with both degrees (5% did not answer this question).

Respondents varied in age, as demonstrated by the year in which they earned their most recent degree. The years of most recent degree range from 1949 to 1998, with two-thirds receiving their last degree between 1970 and 1990.

The respondents also represented diverse fields of medicine, including (in order of frequency) pediatrics (10%), surgery (9%), neurologically related disciplines (8%), internal medicine (6%), family medicine (5%), pathology (5%), pharmacology (5%), radiology (5%), and all other fields of medicine (42%). Because the response rate was only 30%, we compared the fields of respondents with those of the population. The relative representation by respondents was close to that of the population, with slightly higher percentages of pediatrics and surgery in the respondents.

These faculty members divide their time between research, teaching, and clinical practice. Thirty of the respondents do no clinical practice; however, only thirteen do no research, and only two do no teaching. The majority of respondents spend no more than half of their time on any one of these activities, and most divide their time fairly evenly. It should be noted that many readings that the respondents reported came from personal subscriptions, which are personally addressed to them at home, office, or lab.

Questionnaire

The questionnaire replicated others used by Tenopir, King, and colleagues in more than fifty readership surveys dating back to 1977. Some of these surveys were directed to medical professionals such as readers of the *Journal of the National Cancer Institute,* clinicians and researchers at the National Institutes of Health, and medical researchers in pharmaceutical companies (e.g., Bristol-Myers Squibb) and several other health care companies (e.g., Baxter Healthcare).

These questionnaires included reader-related questions and reading-related questions. The reader-related questions addressed amount of reading, number of personal journal subscriptions, and general demographic characteristics. Amount of scholarly reading was measured by asking respondents how many articles they had read in the past month (30 days). Scholarly articles were defined to include ''those found in journal issues, author Websites, or separate copies such as preprints, reprints, or other electronic or paper copies.'' Reading was defined as ''going beyond the table

of contents, title, and abstract to the body of the article.''

To address reading-related questions, we asked respondents to focus on the specific article read most recently to uncover details about this reading. Such details included how the readers first learned about the article, where they obtained it, how much time was spent obtaining and reading the article, what the format of the article was when last read, what the age of the article was, and what the consequences of having read the article were. The power of this technique (a variation of ''critical incident'') lies in the fact that every reading is different. Thus, one can observe detailed patterns of information seeking and reading such as how older articles are identified or where they are obtained, what proportion of reading from personal subscriptions or from library collections are in electronic format, and so on. Such details about a specific reading are more likely to be recalled accurately by the respondent than asking general usage kinds of questions. In this way, one can explore hundreds of combinations of information-seeking and reading patterns of interest.

The critical incident technique has been used for over a half century to analyze reports of human behavior. For information-related studies, the critical incident technique has been applied in basically two ways. One approach has been to identify an ''incident'' in which information may be needed, such as to solve a personal problem. Sometimes the incident is particularly noteworthy such as a physician diagnosing or treating an illness. Once an incident is identified, the research establishes the information-seeking behavior of the physician in addressing the problem. Another approach is to identify an information service incident or event such as an online bibliographic search or a reading of an article.

A well-known MEDLINE study used this approach [19, 20]. The MEDLINE approach relied on incidents in which the searches were either especially effective or ineffective. The searcher was then asked a series of questions about the initial information read and search aspects. Our variation of the critical incident involves an ''incident'' of reading as defined above. The reader is asked critical questions such as the purpose of reading and a series of behavior questions about how the article was found, where it was obtained, and what the outcomes of having read the article were. The incident is the event about which behavior is determined.

The reader-related and reading-related questions imply different statistical sample designs. For some reader-related estimates, the 79 responses were treated as simple random sample observations with the universe being all medical faculty at UT. For example, the average number of readings per respondent was estimated to be 26.8 readings per person per month or 322 readings per year. The confidence interval for this estimate is 322 $\pm$ 67 readings per person per year at the 95% level of confidence.

The reading-related questions pose a problem, because the universe is the total number of readings by physicians, and each such reading has a different probability of selection. That is, the readings of a respondent who reads a great deal have a higher probability of entering the sample than the readings of someone who reads little. One way to address this problem is to post-stratify responses into ranges of amount of reading and base estimates on stratified random samples, where the total amount of reading in each stratum represents the total population of readings for that stratum. The estimated population of readings from which the selection is made is 25,122 readings. In this way, one can at least account for differences in estimates among frequent and infrequent readers and their readings. An example is given in Table 1 for this approach for estimating the number and proportion of readings done from personal subscriptions.

Table 1
Examples of estimating proportion of reading from personal subscriptions using a post-stratified sample

Strata (readings)	Sample (n_i)	Total readings (N_i)	Proportion from personal subscription (%)	Total personal subscription readings
0–10	22	1,818	54.5	991
11–20	27	5,928	70.4	4,173
21–50	20	7,956	60.0	4,774
> 50	9	9,420	55.6	5,238
All	78	25,122	60.4	15,176

For this example, we established four strata based on reported amount of reading by respondents. For example, 22 of the respondents reported 10 or fewer readings, and these readings averaged 82.64 annual readings per person. Thus, the total number of readings in this stratum was estimated to be 1,818 readings (i.e., 82.64 $\times$ 22). Twelve of the 22 reported last readings were said to be from personal subscriptions, so 54.5% of the readings in this stratum were estimated to be from personal subscriptions. Thus, one would expect there to be about 991 of these readings from personal subscriptions (i.e., 0.545 $\times$ 1,818). This estimation process is done for each of the four strata as shown in Table 1.

The estimated total number of readings by the 78 respondents is 25,122, and 15,176 of these readings are estimated to come from personal subscriptions. Thus, the estimated proportion of readings from personal subscriptions is 60.4% (i.e., 15,176 $\div$ 25,122).

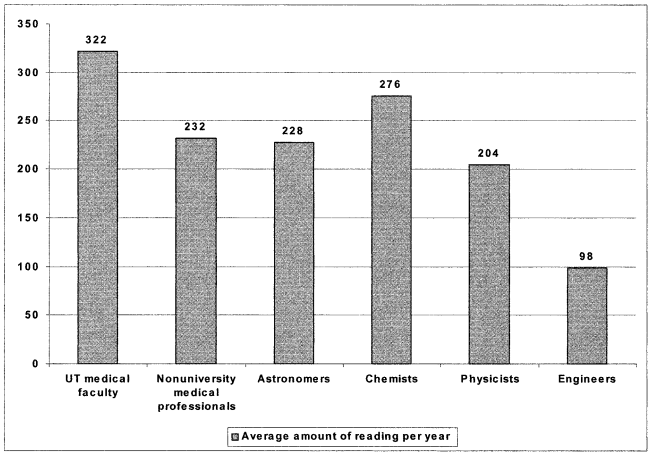
The confidence interval for this estimate is 60.4% $\pm$ 9.4% at the 95% level of confidence. Had we treated the observations as a simple random sample in the manner done for reader-related questions, the proportion of reading from personal subscriptions would be 61.5% $\pm$ 10.8% at the 95% level of confidence. Thus, there is not an appreciable difference in the two estimation methods.

DISCUSSION

Amount of reading

As shown in the methods section, the UT medical faculty read a great deal, but the amount of reading var-

Figure 1
Average amount of reading by medical faculty, nonuniversity medical professionals, and scientists



ied substantially among faculty members. The highest reported amount of reading was 120 readings in the last month, and the least was four readings (reported by five respondents). The average number of readings per month was 26.6 or about 322 readings per person per year (found by multiplying the monthly average by 12, assuming all months being equal).

This amount of reading by medical faculty was higher than that observed in earlier surveys of nonfaculty medical professionals. From 1978 to 1995, King Research conducted several studies of medical professionals at the National Institutes of Health, cancer researchers located nationally, and researchers in several health-related firms (i.e., Bristol-Myers Squibb, Johnson & Johnson, Baxter Healthcare, Colgate-Palmolive, and Protector & Gamble) [21]. Medical professionals in nonuniversity organizations averaged only 232 readings per year, but, in all surveys, medical professionals tended to read more than other professionals, such as astronomers (228 readings per year), chemists (276 readings), physicists (204 readings), and engineers (98 readings) (Figure 1). That medical faculty read more articles than any other profession was not surprising, as it confirmed similar findings and numbers of readings from earlier articles by Tenopir and King.

Usefulness and value of articles

Professionals tend to read scholarly articles a great deal because of the usefulness and value of the information obtained from the articles. The principal purpose for which medical faculty read scholarly articles is most often reported to support primary research (30% of readings). We asked respondents to indicate how important the information content in the last article read is to achieving the principal purpose for which the article is read. Importance is rated from 1, meaning not at all important, to 7, meaning absolutely essential. The average importance rating of information used for primary research is 5.09. Other principal purposes of reading and average ratings of importance are shown in Table 2.

Table 2
Proportion of readings of scholarly journals by University of Tennessee medical faculty for various principal purposes and average ratings of importance of information in achieving the principal purposes: 2000 to 2001

Principal purpose of reading	Proportion of readings (%)	Average ratings of importance*
Primary research	29.9	5.09
Current awareness/keeping up	22.1	4.58
Teaching	16.9	4.92
Writing	11.7	5.56
Other purposes	9.0	4.29
Background research	6.5	4.20
Consulting, advising others	3.9	6.00
All	100.0	

* Importance ratings: 1, not at all important, to 7, absolutely essential.
Source: Survey of University of Tennessee Medical Faculty (n = 77).

The principal purposes for reading reflect the roles of medical faculty. The four highest ratings of importance of information read in achieving the principal purpose reflect their four most basic roles, that is, primary research (5.09), teaching (4.92), writing (5.56), and consulting or advising others (6.00).

We also asked the medical faculty to indicate the ways the principal purpose was affected. Here, respondents were given the opportunity to indicate multiple ways. The most frequently mentioned ways were that the reading ''inspired new thinking or ideas'' and ''improved the result of a purpose for reading'' (55% of readings for each way). Other frequently reported ways included that reading ''narrowed, broadened or changed their views'' of the purpose (30% of readings), ''saved time or other resources'' (16% of readings), and ''resolved problems'' (12% of readings). Other ways mentioned were that it ''resulted in collaboration or joint research'' and ''resulted in faster completion.'' On the other hand, one respondent, who spent fifteen minutes reading an article, reported that the reading ''wasted my time.''

One assessment of the usefulness of the scholarly journal information is whether or not the readers know about the information reported or discussed in the last article read. Approximately 54% of the readings provided new information; a proportion somewhat higher (about 5 to 15% higher) than observed in other disciplines.

Another factor of value is the level of care of each reading. The medical faculty respondents reported that they most frequently read with attention to the main points (54%). The survey showed that medical faculty read articles rather thoroughly. Seventy-three of the seventy-nine respondents read articles paying attention to the main points or with great care (59% and 38%, respectively). Most of the respondents (84%) also reported that they had not read the article prior to this particular reading, which might account for the amount of detail spent reading the article.

One indicator of the value of scholarly journal information is the amount of time a reader is willing to spend reading the journals. Clearly, medical professionals' time is a scarce resource, and any decision to use this resource demonstrates how valuable the purpose for using it is. The medical faculty at UT spend on average about 120 hours per person per year reading scholarly journals. This is much less time than that observed for other medical professionals described in other studies, who have been observed to spend an average of about 305 hours per year [22]. Other professionals tend to spend more time reading scholarly articles: astronomers (144 hours per year), chemists (198 hours), physicists (153 hours), and engineers (92 hours). (More is said about the medical faculty time later.)

As mentioned above, the majority of the readings came from articles published in the past year. In a study by Tenopir et al. [23], 37% of scientists who read articles more than two years old were not reading them for the first time, meaning that 37% were rereads. About 16% of the medical faculty's corresponding reading were rereadings. Medical faculty seemed to perform more first-time readings (84%) than scientists and sought to perform more in-depth reading during these first time readings. One reason for this greater depth of first-time readings, again, could stem from the greater need for current awareness in the medical profession.

Another indicator of the usefulness and value of scholarly journals to medical faculty is the outcome of reading. In other studies, the amount of reading has been shown to be positively correlated with five indicators of reader productivity [24]. In this survey, we found that medical faculty who read more tended to have published more journal articles in the last two years. Finally, we determined whether respondents had, in the past two years, received any awards or special recognition for their research or other profession-related contributions. The 40% who had received such recognition averaged about 395 readings per year, compared with 270 readings for those who had not received such recognition. Thus, award recipients tended to read more than others. This result has been observed in nearly all of our surveys of scientists and other professionals but, of course, this does not imply cause and effect.

Medical library contribution to the use, usefulness, and value of scholarly journals

About 22% of the readings by medical faculty is from library-provided articles, that is, about 70 readings per year. However, these readings tend to be described as more useful and valuable than readings from other sources. While the principal purposes of reading library-provided articles are similar to those for articles obtained from other sources, the importance ratings tend to be higher for library-provided articles (5.00 versus 4.88), a tendency consistently observed by Tenopir and King. The average time spent reading library-provided articles is greater than those obtained from other sources (28 minutes per reading versus 20 minutes), thus indicating that the library-provided articles may be more valuable. The award recipients who last read a library-provided article average 502 readings per year versus 334 readings by award recipients who use nonlibrary sources. Thus, library-provided articles appear to yield more useful and valuable articles.

Information-seeking patterns of medical faculty

Medical faculty at the University of Tennessee in 2000/01 continue to rely heavily on traditional print journals. In fact, about 70% of readings are from print subscriptions (60% personal subscriptions, 10% library subscriptions). This proportion is higher than the proportion observed with science faculty at the main campus at the University of Tennessee, Knoxville (UTK), where 65% of readings are from print subscriptions. The medical faculties' preference for print journals is tied to the fact that so many of the readings are from their personal subscriptions (i.e., subscriptions which are personally addressed to them at their home, office, or lab). They average 6.3 personal subscriptions per person, which is much higher than that observed for other UTK science faculty (3.8 subscriptions). They also read more from their personal subscriptions (i.e., 31 readings per subscription title versus 21 readings for UTK science faculty).

These phenomena are highly consistent with results observed earlier in our surveys of medical professionals (1978 to 1995). This result is also corroborated by research by Curtis, Weller, and Hurd [25], who find that 78% of medical staff rely on personal subscriptions, and Stinson and Mueller [26], who observe that health professionals use their personal libraries for their source of information. Bowden, Kromer, and Tobia [27] also find that most physicians prefer to use their personal journal collections when conducting research.

Ely, Levy, and Hartz [28] claim that physicians seek ''highly digested information'' and value rapid access and understandability more than quality or currency of information, and they are more likely to get this information from their personal collections. This result is somewhat at odds with our earlier studies of medical clinicians and researchers who indicated in focus group and in-depth personal interviews that currency is extremely important to them. The importance of currency appears to be true with the UT medical faculty as well, based on their purposes for reading and the age of articles read. Over half of the readings were said to be for current awareness or keeping up as a principal or other purpose (54% of readings). About 85% of readings are of articles less than 1 year old, and only 1% of the readings are over 5 years old.

This proportion of reading of current articles was also found to be true in our earlier medical professional surveys; however, it was contrary to the reading patterns of other professionals. For example, 72% of readings of scientists and social scientists at UTK were of articles less than 1 year old and 10% involved readings over 5 years old. This latter pattern is consistent

Table 3
Proportion and average number of readings by University of Tennessee medical faculty by source of article read: 2000 to 2001

Medium of article read	Proportion of reading (%)	Number of readings per person
Library	22.1	71
Print subscription	(10.4)	(33)
Electronic subscription	(11.7)	(38)
Personal subscription	62.3	200
Print	(59.7)	(192)
Electronic	(2.6)	(8)
Free Web Journal	5.2	17
Separate Copies	10.4	34
Reprint	(3.9)	(13)
From colleagues, author, etc.	(2.6)	(8)
Personal photocopy	(3.9)	(13)
Total	100.0	322

Source: Survey of University of Tennessee Medical Faculty (n = 77).

Table 4
Proportion and average amount of reading by University of Tennessee medical faculty by means of learning about articles that are read: 2000 to 2001

Means of learning about articles read	Proportion of reading (%)	Number of readings per person
Browsing	62.3	201
Library print subscription	(1.3)	(4)
Library electronic subscription	(3.9)	(13)
Personal print subscription	(50.6)	(163)
Personal electronic subscription	(3.9)	(13)
Other digital collections	(2.6)	(8)
Online search	16.9	54
Indexing or abstracting database	(11.7)	(38)
Current awareness service	(3.9)	(12)
Online journal collection	(1.3)	(4)
Other	20.8	67
Cited in another publication	(9.1)	(29)
Another person informed reader	(6.5)	(21)
Print current awareness	(1.3)	(4)
Other method	(3.9)	(13)
Total	100.0	322

Source: Survey of University of Tennessee Medical Faculty (n = 77).

with distribution of age of articles read observed for scientists over the past forty years by Tenopir and King. Table 3 shows some detail concerning where medical faculty obtained the articles they read.

About 22% of the readings are from library subscriptions (with no reported readings from interlibrary loan or document delivery), and just over one-half of these are from library electronic subscriptions. Note that it is not known whether the free Web journals are received personally or are library subscriptions that are not known as such by the readers. About 62% of readings are from personal subscriptions, but only 4% of these readings are from personal electronic subscriptions. About 10% of readings are from separate copies of articles such as reprints, copies sent from colleagues, or personal photocopies.

The sources used by medical faculty to obtain articles was somewhat different than that observed for UTK scientists and social scientists, who used the library for 34% of readings, personal subscriptions for 44%, and separate copies for 22%. Tenopir and King found that university scientists' readings from library-provided articles increased from 25% in 1977 to 55% in 1993, but, for all scientists, the proportions went from 13% of readings to about 56%. As shown in Table 4, a substantial amount of reading involves browsing library or personal collections.

Again, the dominance of articles found by browsing and from current awareness sources (67.5%) implies that much of the reading is to keep current. Also, the amount of time spent reading through browsing is somewhat less than articles identified in other ways, and these readings are far less likely to be read with great care (29% of readings found while browsing versus 53%).

Scientists and social scientists at UTK use similar means to learn about the articles they read. For example, 49% of articles are found by browsing, 22% by online search, and 29% by other means.

Another study [29] has provided some evidence that it takes readers more time to browse personal electronic journals than personal print subscriptions but much less time to browse library electronic journals than library print journals. This may account for the fact that only 4% of browsed readings of personal subscriptions involve electronic journals, whereas 53% of browsed library subscriptions are from electronic versions.

Also, the other scientists' surveys dating back to 1977 by Tenopir and King show that the readings from personal subscriptions have decreased from 68% to about 27%, due in large part to substantial increases in price and subsequent decrease in personal subscriptions. Our studies show that it costs the scientists less, in their time, to go to the library to read when the use of a journal is below a breakeven amount of reading [30]. Scientists now average about twenty-one readings from personal subscriptions, whereas medical faculty read much more—an average of thirty-one readings—making their use of personal subscriptions still above breakeven points in their time when compared to using library subscriptions. However, that is likely to change if the amount of time required to obtain library electronic journals continues in a downward trend compared with the cost of print journals.

We asked the medical faculty about their awareness and use of the National Institutes of Health/National Library of Medicine's PubMed.† A very high proportion of the medical faculty were aware of the service (89% of 75 respondents). Of those who indicated that they were aware of the service, many used the service in the past twelve months (87% of the 67 respondents who answered this question were aware), and those who used the service averaged using it about fifty-five

† The National Institutes of Health/National Library of Medicine's PubMed Website may be viewed at http://www.ncbi.nlm.nih.gov/PubMed/.

Table 5
Average number of readings by University of Tennessee medical faculty by their educational degree and format read: 2000 to 2001

Educational degree	Print	Electronic
Medical degree only	33	1
Doctorate only	18	17
Both medical degree and doctorate	1	0
Neither degree	4	0
Total	56	18

times in the last twelve months (or about once a week). They averaged reading a little over one article per use.

Information-seeking patterns by types of medical faculty

There are some differences in preferences for print versus electronic; however, medical faculty rely on traditional print journals for most of their readings. While there seems to be no difference in preferences by medical subfield, there is a difference by educational degree. Faculty with medical degrees read more in print resources than electronic resources, while medical faculty with doctoral degrees are split almost evenly between print and electronic resources (Table 5).

As shown in Table 6, dates the last degree was earned by the respondents range widely, but, in this study, age of the respondent does not seem to be a factor in whether they read more in print or electronic journals. However, in another survey of a different type of scientist (astronomers) by Tenopir and King, age may have been an influence in the use of print and electronic journals. Over 40% (40.2%) of the scientists between the ages of 31 and 40 use electronic journals as the source of the article last read, while only 16.3% of scientists between the ages of 51 and 60 use electronic journals as the source of the article they last read. Conversely, 11.2% of the scientists between the ages of 31 and 40 use print journals for the source of the article last read, while 30.3% of scientists aged 51 and 60 use print journals as their source of the article last read. Even though the comparable percentages are high (40.2% to 16.3%) for younger scientists' use of electronic journals versus older scientists' use of electronic journals, these data could support the idea that the ages of 31 and 40 represent the ages when the most amount of research is conducted. Another factor to consider between the fields of medicine and astronomy is that all of the major astronomy journals are published electronically.

Many respondents (30) spend 11 to 20 minutes per reading. Of these 30 respondents, 53% are medical degree–holding faculty; 40% are doctorate-holding faculty; 7% hold neither degree. Twenty-three of the 72 respondents (32%) who replied to the statement, ''Please indicate your best estimate of the time in minutes that you spent reading this article the most recent time,'' spend 30 minutes or more per reading. These respondents' degrees were almost evenly split between doctorate and medical degree (11 doctorates, 10 medical degrees, and 2 neither).

Table 6
Proportion and average number of readings by University of Tennessee medical faculty by the year of last degree and format read: 2000 to 2001

Year of last degree	Frequency	Percent	Last reading format	
			Print	Electronic
1951–1970	23	29.1	19	3
1971–1980	28	35.4	22	5
1981–1990	22	27.8	15	7
1991–2000	5	6.3	4	1

Source: Survey of University of Tennessee Medical Faculty (n = 79).

CONCLUSIONS

Journal reading patterns of university medical faculty exhibit some important differences and similarities with other scientists. Medical faculty read more articles than others on average but spend less time on average per article. They value currency but also need information formatted and summarized in a way to save them time. This creates a tension for publishers and librarians, who must find ways to provide both current information and articles formatted in a way that makes them easy to identify and quick to read.

Like other scientists, medical faculty value journal articles and rely on them to do their various jobs. Convenience is an important factor in reading and medical faculty nonetheless often depend upon personal print subscriptions for convenience. Librarians and publishers must find ways to provide the convenience of a portable and readily available personal subscription in electronic journals for medical professionals.

Journal article delivery to portable, handheld devices may match the work and reading habits of medical professionals. In all other fields, the importance of library subscriptions has increased as prices increase and personal subscriptions decrease. This phenomenon has been slower with university medical faculty but may occur as subscription prices continue to rise and as electronic alternatives become more widely available.

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